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CLINICAL RESEARCH

Assessing cardiovascular risk factors after coronary artery bypass surgery: value of an aggressive strategy including systematic follow-up

Évaluation des facteurs de risque cardiovasculaire après pontages aorto-coronariens : intérêt d'une stratégie agressive avec mise en place d'un suivi systématique

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KEYWORDS

Coronary artery
bypass surgery;
Risk factors;
HBP;
Cholesterol;
Smoking;
Diabetes;
Education.

Summary

Introduction. — Coronary revascularization surgery is a palliative treatment modality which should not preclude efforts to treat atherosclerosis.

Aim. — To assess ongoing cardiovascular risk factors after coronary artery bypass surgery and develop a strategy to attenuate such factors.

Methods. — 108 patients requiring a coronary artery bypass were included: 2 died soon after surgery and 6 were excluded for personal reasons. 100 patients were re-admitted into hospital 7 months after surgery for risk factor assessment. Eight months later, they were re-contacted by telephone (systematic follow-up) for a re-assessment.

Results. — The population consisted of 77 men with an average age of 64 ± 11 years. Prior to the operation, the known risk factors were: smoking 34%; HBP 61%; cholesterol 47%; diabetes 30%; obesity 25%.

During their hospital stay six months after the procedure: 91% of the patients had at least one lipid metabolism abnormality. New-onset diabetes was diagnosed in 5%. Blood pressure was uncontrolled in 18% and 10% were still smoking. Patients tended to be putting on weight and 55% engaged in little or no physical activity.

Systematic follow-up: lipid metabolism had normalized in 70% of the patients. Blood glucose levels were significantly lower. Blood pressure was uncontrolled in 9% and 4% were still smoking. Their weight had stabilized and 65% were engaging in moderate-to-strenuous physical activity.

Conclusion. — Inadequate attention is paid to risk factors after coronary artery bypass surgery. A short hospital stay including a cardiovascular evaluation and education about risk factors has a positive impact on the management of atherosclerosis in the medium term.

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MOTS CLÉS

Pontage aorto
coronaire ;
Facteurs de risque ;
HTA ;
Cholestérol ;
Tabagisme ;
Diabète ;
Éducation.

Résumé

Introduction. — La revascularisation coronarienne chirurgicale reste un traitement palliatif qui ne doit pas occulter les objectifs de traitement de la maladie athéroscléreuse.

But. — Évaluer le devenir des facteurs de risque cardiovasculaire après pontages coronariens et optimiser une stratégie de réduction de ces facteurs.

Méthode. — Cent huit patients nécessitant des pontages coronariens ont été inclus. Deux sont décédés précocement après chirurgie, 6 sont exclus pour raisons personnelles, 100 patients ont été hospitalisés 7 mois après pontages pour évaluation des facteurs de risque. Ils sont contactés par téléphone (suivi systématique) 8 mois plus tard pour une nouvelle évaluation.

Résultats. — La population était constituée de 77 hommes dont l'âge moyen était de 64 ± 11 ans. Les facteurs de risque préopératoire connus étaient : tabac 34 %, HTA 61 %, cholestérol 47 %, diabète 30 %, obésité 25 %.

Lors de leur hospitalisation à 6 mois de l'intervention, 91 % des patients présentaient au moins une anomalie du métabolisme lipidique. Chez 5 % des patients, un diabète était découvert ; 18 % présentaient une tension artérielle non contrôlée et 10 % fumaient encore activement. Les patients prenaient du poids et leur activité physique était nulle ou faible dans 55 % des cas.

Lors de leur suivi systématique, le métabolisme lipidique était normalisé chez 70 % des patients. La glycémie était significativement plus basse. Neuf pour cent des patients présentaient une tension artérielle non contrôlée et 4 % fumaient encore activement. Le poids était stabilisé et 65 % avaient une activité physique modérée ou importante.

Conclusion. — Les facteurs de risque ne sont pas suffisamment pris en charge précocement après des pontages coronariens. Une courte hospitalisation pour une évaluation cardiovasculaire et une optimisation de ces facteurs de risque, associée à une éducation des patients, est bénéfique à moyen terme dans la prise en charge de la maladie athéroscléreuse.

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Introduction

The incidences of both ischemic cardiomyopathy and ischemic heart failure are on the rise in Western countries [1, 2]. Despite new medical treatment modalities and the development of percutaneous revascularization techniques, bypass surgery remains the reference treatment for coronary heart disease involving the three arteries [3]. However, this is still a palliative procedure with as yet unresolved problems. Despite the development of "all-arterial" revascularization techniques, many situations call for venous grafts which tend to deteriorate over time leading to the recrudescence of ischemia [4, 5]. Better understanding of the vascular physiology of venous grafts has helped to improve long-term outcomes in myocardial revascularization but this does not make the global management of cardiovascular risk factors any less important, one of the goals being to prevent graft deterioration and exacerbation of the coronary heart disease. It is well established that global cardiovascular risk factor control reduces morbidity and mortality [6-8]. Less importance seems to be attached to such control with patients who have already undergone surgical myocardial revascularization [6, 7, 9]. Effort needs to be dedicated to reach secondary prevention targets in order to reduce mortality and morbidity [10]. At our institution, we have instigated an optimal personalized care program for secondary atherosclerosis prevention. In the work described here, an early evaluation of cardiovascular risk was programmed after a simple surgical myocardial revascularization procedure. We established a new, relatively aggressive strategy for controlling risk factors involving a short stay in hospital aimed at correcting our patients' lack of awareness of the problems, optimizing drug regimens, and preventing drift in the management of cardiovascular risk factors.

Patients and methods

Study design

In this prospective, single-center study, the inclusion criteria were based on the indication for myocardial revascularization by coronary artery bypass surgery, according to ESC and AHA criteria [3]. All the patients were from the same cardiology department. After the surgical team had reviewed the patient's records, the operation was electively scheduled. For this study, cardiovascular risk factors were exhaustively reviewed prior to the operation. The patient was revascularized and after the operation, was transferred to a re-education unit for a three-week stay. Six months after the procedure, all patients were re-admitted into the hospital for a review of their cardiovascular risk factors; at this time, a secondary prevention program was instigated. Finally, about six months after this hospital stay, all the patients were telephoned to gather further information.

Myocardial revascularization surgery

All patients were operated upon by the same surgical team using exactly the same technique. Myocardial revascularization was achieved with extracorporeal circulation at moderate hypothermia (33°C). Cardioplegia was induced using Breitschneider's crystalline solution. All patients were immediately transferred to intensive care for postoperative surveillance and were kept in hospital for an average of 8-10 days before discharge to the re-education unit.

Re-admission after six months

Six months after the myocardial revascularization operation, all patients were hospitalized for three days for an

exhaustive review of their risk factors and instigation of the secondary prevention program. Left ventricular ejection fraction was estimated by both ultrasonography and isotopic ventriculography. Residual myocardial ischemia was systematically investigated by MIBI myocardial scintigraphy. Every patient's tobacco consumption, eating habits and physical activity were evaluated, and body mass indices were calculated. Blood pressure was monitored for one hour with the patient lying down; the mean of five measurements was calculated. Fasting blood was drawn to measure total, LDL and HDL cholesterol, triglycerides, glucose, glycosylated hemoglobin and fibrinogen. A dietitian dispensed advice about healthy eating habits, the target being to cut down fat consumption to less than 30% of total energy intake with saturated fatty acid intake below 10%. Eating cereals, fiber and fruit was recommended. All active smokers were given special counseling and nurses and heart specialists from the department provided them with information about the associated risk factors. Various types of information about cardiovascular disease and the benefit of controlling risk factors were covered. Discharge treatment regimens were adjusted on the basis of risk factors and the patients' cardiac status, in line with ESC and AHA guidelines [3].

Measurement of the atheroma burden

Carotid atheroma

All patients were given cervical ultrasound examinations by the same technician before and after the operation. Narrowing was expressed as a percentage of reduction in diameter according to NASCET criteria. The values retained in this work were stenosis of over 20%.

Arteriopathy in the lower limbs

Systolic Pressure Index measurements were all made with the patient having been resting in the supine position for at least five minutes. Posterior and pedal doppler signals were recorded using a continuous Crayon probe at 8 MHz: humeral pressure was then measured and the SPI calculated (the ratio between the highest humeral pressure and the highest ankle pressure).

Systematic monitoring

All patients were re-contacted about six months after this re-admission into hospital. Information was gathered on all cardiovascular events as well as on changes in lifestyle and treatment. Quality of life was also evaluated (SF 36). If a cardiovascular event had occurred, all the relevant information and hospital records were inventoried.

Statistical analysis

The Protocol was approved by the University Hospital Center's Methodology Group. All the data were analyzed using descriptive and analytical statistics. Differences in the distribution of categorical variables were tested using the Chi² test and those in continuous variables using the paired "t" test. These analyses were run on Statview 5.0.1 software. The significance threshold was $p < 0.05$.

Results

Characteristics of the population

A total of 108 successive patients requiring a coronary artery bypass were included. Two patients died following the procedure, and six who did not wish to participate in the follow-up phase were excluded. One hundred patients were therefore admitted 207 ± 29 days after their surgery (the Hospitalization Group). They were subsequently re-contacted by telephone 260 ± 15 days later for re-evaluation (Systematic Follow-up Group). The patients' characteristics, including the severity of their condition before the operation and details of the surgery are given in [table 1](#) and [figure 1](#).

Table 1 Intervals between surgery, re-admission and systematic follow-up. Patients' characteristics, disease severity, number of bypasses and percentage of venous grafts.

Interval between surgery and re-admission (days)	207.1 \pm 29.7
Interval between re-admission and systematic follow-up (days)	260 \pm 15.4
Interval between surgery and systematic follow-up (days)	494 \pm 36
Number of patients	100
Mean age (years)	64 \pm 11
Females (%)	23
Severity (Euroscore)	5.6 \pm 2.5
Mean number of bypasses	2.6 \pm 0.6
Venous grafts (%)	60

Evaluation of risk factors at 6 months: re-admission

Habits

At the time of re-admission, 55% of the patients were engaging in little or no physical activity. Patients with a high pre-operative body mass index had continued putting on weight, and 10% of patients were still smoking ([table 2](#)).

Blood pressure

Mean systolic blood pressure was 123.9 mm Hg, and mean diastolic pressure was 67.8 mm Hg. At the time of admission, 18% of patients had a systolic pressure of over 140 mm Hg ([table 3](#)). Left ventricular hypertrophy was observed in 7% of patients according to electrical measurements, and in 25% according to ultrasound.

Laboratory tests

Total, LDL and HDL cholesterol as well as triglyceride levels are shown in [table 3](#). It is worth noting that LDL cholesterol was abnormal in nearly 70% of the patients, that HDL was

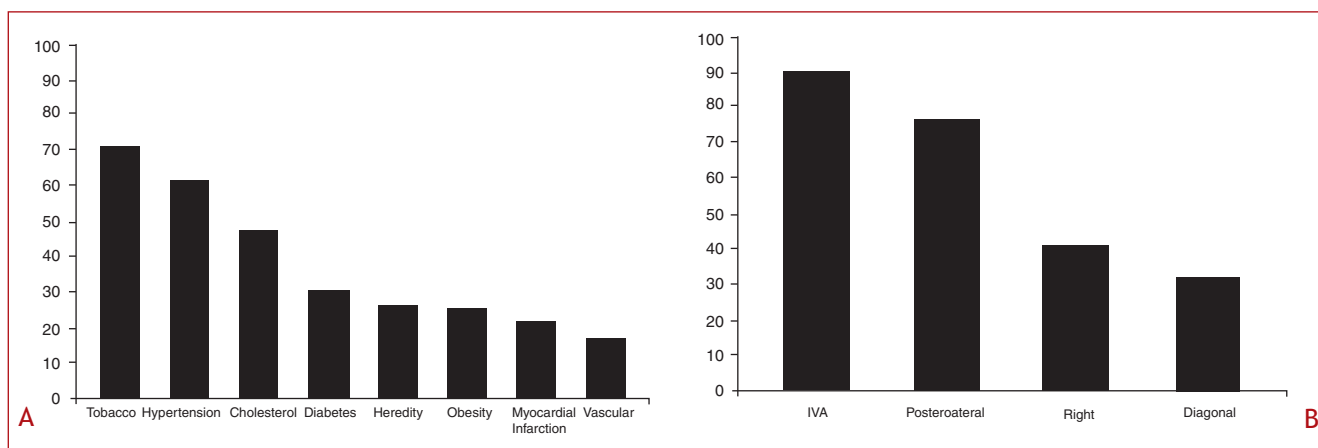


Figure 1. Mapping of coronary artery bypasses.

Table 2 Physical activity, body mass index and smoking before and after surgery. NS = not significant. For physical activity, the *p* value compares re-admission and systematic follow-up. For smoking, the *p* value compares before the operation and re-admission.

	Before the operation	Re-admission	Systematic follow-up	p
Physical activity				
Little or none (%)	45	55	35	0.05
Moderate (%)	43	35	52	0.05
Strenuous (%)	12	10	13	NS
Body mass index				
Mean (IU)	27.39±3.6	27.9±4.7	27.9±4.1	
<25	30	27	26	
25-30	45	42	41	
>30	25	31	33	
Smoking				
Never smoked (%)	29	29	29	
Former smoker (%)	37	61	67	0.05
Still smoking (%)	34	10	4	NS

abnormal in one patient in two, and that 23% had abnormal triglycerides; in all, 91% of the re-admitted patients presented at least one lipid metabolism abnormality six months after the myocardial revascularization procedure. Details on glucose metabolism are shown in table 3: new-onset diabetes was observed in 5% of patients although mean blood glucose and glycosylated hemoglobin levels were within the normal range.

Left ventricular function and residual ischemia

The mean preoperative isotopic ejection fraction was $58.36\% \pm 16.1\%$ with 11% of patients having an EF of below 40%, and 12% one of between 40 and 50%. The mean postoperative EF was not significantly higher but it had significantly risen in those with severely impaired function prior to the operation (i.e. an EF of under 40%, $p < 0.05$). After

revascularization, 30% of patients were still ischemic: the various territories involved are shown in figure 2 C.

Peripheral atheromatous burden

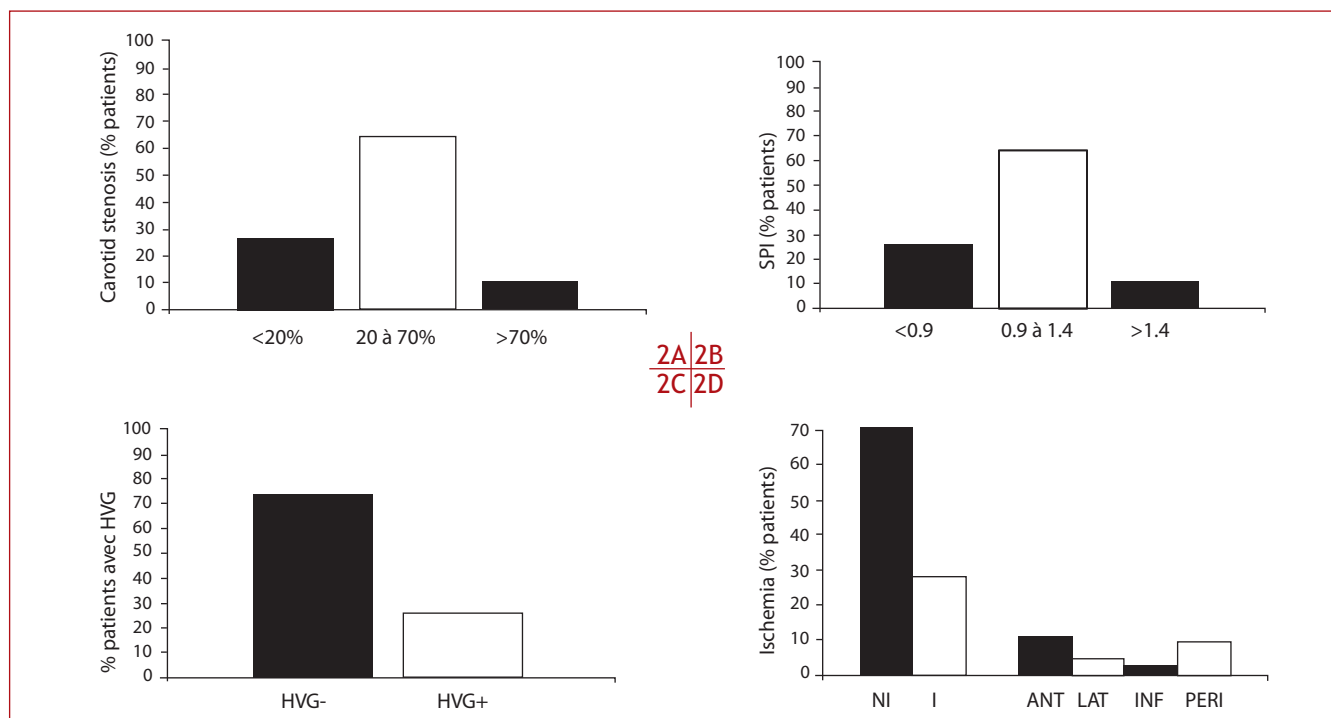
With respect to endarteritis obliterans in the lower limbs, 27% of patients presented an SPI of under 0.9, some with symptoms and others without (figure 2 B). Carotid stenosis of over 70% was detected in 10% of patients; such severe narrowing had not been observed prior to the procedure (figure 2 A).

Treatment

Cardiovascular treatment modalities are shown in figure 3. 72% of patients were taking at least one anti-ischemic drug. Most of the other 28% were untreated for reasons of intolerance. 93% of patients were on at least one anti-platelet or

Table 3 Risk factors (laboratory test results and blood pressure parameters) after surgery and at systematic follow-up. the *p* value compares re-admission and systematic follow-up.

	Before the operation (n=100)	Re-admission (n=100)	Systematic follow-up (n = 100)	<i>p</i>
Total cholesterol (mmol/L)	5.01±1.01	4.98±1.12	4.75±1.1	<0.0001
LDL C (mmol/L)	3.09±1	3.02±1	2.84±0.9	<0.0001
% of patients with LDL >2.58 mmol/L	70	68	55	
HDL C (mmol/L)	1.35±0.3	1.34±0.3	1.36±0.3	NS
% of patients with HDL <1.29 mmol/L	50	51	52	
Triglycerides (mmol/L)	1.58±0.9	1.51±1.1	1.4±0.9	<0.05
% of patients with TG >1.69 mmol/L	24	23	20	<0.05
Systolic blood pressure (mm Hg)	128.9±14.2	123.9±16.9	131.8±14	<0.01
Diastolic blood pressure (mm Hg)	69.78±8.8	67.8±10.9	77±10	<0.01
% of patients with SBP ≥140 mm Hg	20	18	9	<0.01
Blood glucose (mmol/L)	6.6±4.4	6.4±4.4	5.8±1.6	<0.01
HBA1C (%)	6.8±1.7	6.6±1.4	6.2±1	<0.05
% of diabetic patients	30	35	35	

**Figure 2.** (A) Evaluation of carotid stenosis. (B) Evaluation of systolic pressure index (SPI). (C) Evaluation of the percentage of ischemic patients (scintigraphy). (D) NI = not ischemic, I = ischemic, Ant = anterior, Lat = lateral, Inf = inferior, Peri = perilesional.

anticoagulant drug, and only 80% were on a statin. In the 20% who were not taking any drug, the main reasons were adverse muscle or liver reactions. 20% of these patients were on a weak statin. Only 60% of the patients were taking a combination of an anti-ischemic drug, an anti-platelet drug and a statin.

Evaluation of risk factors in the follow-up

Habits

All the patients had stepped up their level of physical activity with only 35% still engaging in little or no physical acti-

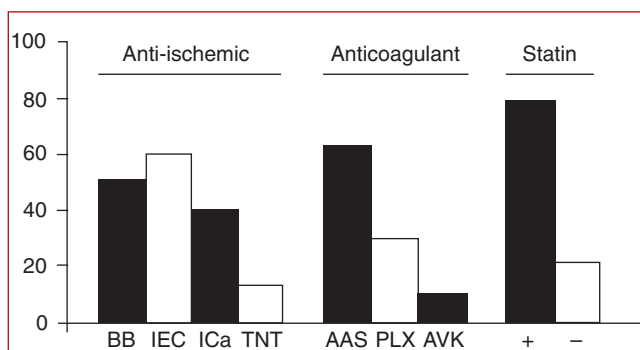


Figure 3. Six-month evaluation of the treatment regimen of patients who have undergone bypass surgery.

BB = beta blocker, IEC = angiotensin converting enzyme inhibitor, ICa = calcium channel blocker, TNT = nitrate derivatives, AAP = anti-platelet drug, PLX = Plavix®, AVK = anti vitamin K.

vity. Body mass index had stabilized although there had been a statistically insignificant rise among the obese patients. Many patients had also given up smoking with only 4% remaining active smokers (table 2).

Blood pressure

The patients' mean systolic blood pressure was 131.8 ± 14 mm Hg and their diastolic blood pressure was $77 \text{ mm Hg} \pm 10$ mm Hg, with only 9% having a systolic reading of over 140 mm Hg.

Laboratory tests

Lipid metabolism had normalized in 70% of patients with significant drops in LDL cholesterol and triglyceride levels (table 3). Both blood glucose and glycosylated hemoglobin had dropped significantly. No new cases of diabetes were observed.

Treatment

Few of the treatment regimens had been changed; the anti-ischemic regimen had been changed in only two patients (by switching from a beta-blocker to a calcium channel inhibitor for reasons of impaired erectile function). 94% of patients were on a combination of an anti-ischemic drug, an anti-platelet drug and a statin.

Cardiac events

Angina had recurred in 5 patients with percutaneous revascularization required in two of them: in both of these procedures, revascularization was carried out in a coronary territory which had not been bypassed. Two patients had heart failure with ischemic cardiomyopathy, even though their grafts were still working satisfactorily. Finally, peripheral arterial revascularization had been practiced in 6 patients suffering from endarteritis obliterans in the lower limbs (and in whom the decision to schedule the vascular procedure had been considered at the time of the coronary surgery) (table 4).

Quality of life

The quality of life evaluation was based on SF 36 [11]. All the patients filled out the questionnaire and the results

Table 4 Cardiac events occurring in the systematic follow-up period following surgery.

Cardiovascular events				
N = 100	Angina	Angina + angioplasty	Heart failure	Peripheral arterial revascularization
Patients (%)	3	2	2	6

were compared to an age-matched group who had not had coronary artery bypass surgery. Overall, the patients had felt well since their surgery with a total SF 36 score of 70%; results for physical and mental health were comparable. However, 65% of the patients were still experiencing dysesthesia or even pain around the sternotomy. Moreover, they reported some degree of emotional fragility with 20% reporting frankly reduced life force (figure 4).

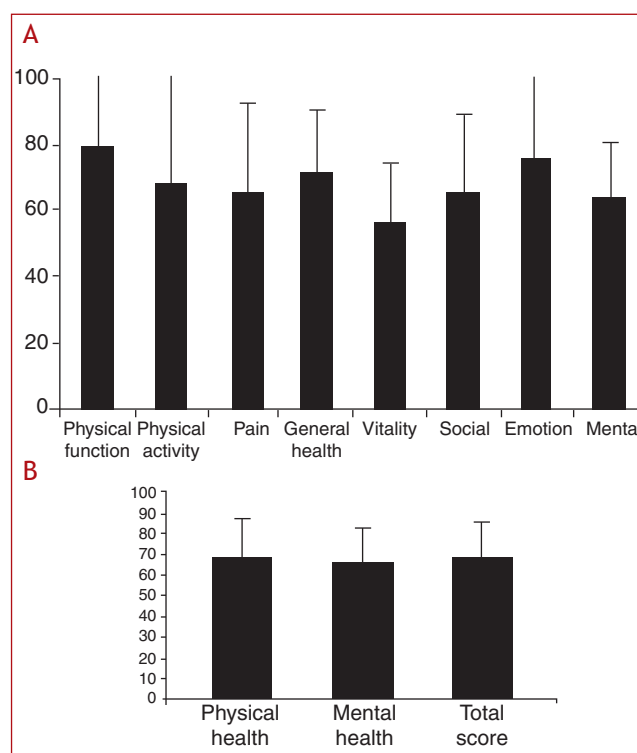


Figure 4. Quality of life SF 36.

A: Specific evaluation. B: Global evaluation.

Lines represent scores for an age-matched subjects who have not undergone coronary artery bypass surgery.

Discussion

Myocardial revascularization by coronary artery bypass surgery remains the reference treatment in patients with multiple arterial involvement. The aim of this procedure is to improve patients' quality of life by attenuating the symptoms, to decrease coronary mortality, and to arrest the progression of heart failure resulting from ischemia [3].

Surgical treatment necessitates the use of arterial and/or venous grafts. Venous grafts may deteriorate over time, notably as a result of atherosclerotic involvement of the graft itself [12]. In these conditions, optimum management of risk factors can only be of benefit vis-à-vis both the original coronary network as well as the graft elements. We sought to evaluate the risk of patients after surgery and optimize risk factor control in order to preclude further damage to the original coronary network and prevent graft deterioration. This strategy necessitates a three-day hospital stay with the instigation of systematic follow-up to ensure holistic care. A special facility for the investigation, prevention and treatment of atherosclerosis was therefore set up at our hospital (*Centre d'Exploration, de Prévention et de Traitement de l'Atherosclerose* - CEPTA). This type of structure constitutes a precious aid for both "medical" and "surgical" patients. The follow-up program is run by heart specialists, specialized nurses and psychologists. This multidisciplinary approach focuses on personalizing atherosclerotic disease and explaining to each patient why managing risk factors and complying with the prescribed treatment regimen is essential. We have observed that, despite optimal discharge prescription given on discharge, following coronary artery bypass surgery, treatments were often substantially changed during cardiovascular re-education. The reasons for this are many and various, often related to the progressively increasing independence of patients (despite all the information dispensed during the re-education period). It is very likely that imperfect compliance was associated with the fact that patients had been provided with inadequate information or failed to fully understand what they had been told. After six months, 40% were no longer taking a full regimen during their hospital stay at the CEPTA as recommended for patients with coronary heart disease. About 20-25% of patients had not consulted their cardiologist since the operation because they had "benefited" from myocardial revascularization surgery. Our delayed strategy makes it possible to re-educate the patients about the chronic nature of atherosclerotic disease, emphasizing the risk they run of cardiovascular complications despite the surgery. We observed that, six months after surgery, the patients were at high cardiovascular risk and attached little importance to stepping up their level of physical activity or giving up smoking. The short hospital stay showed them the expected benefits of simple dietary and lifestyle measures [13]. Systematic, personalized re-evaluation of the drug regimen resulted in adequate treatment for coronary heart disease in over 90% of cases and the process helped foster personalized therapeutic targets. This gave concrete results in terms of the normalization of lipid metabolism, blood pressure balance and control of blood glucose levels—all important parameters when it comes to controlling risk factors [8, 14-18]. Such holistic care engages patients' responsibilities and helps them understand that the procedure is a palliative measure, thereby "reintegrating" them into the cardiological world and promoting compliance. It also helps identify the highest-risk patients and points to when monitoring and medical treatment should be stepped up [8]. This approach therefore helps reduce cardiovascular risk with about 90% of patients being "responders" to the strategy. Non-responders should be monitored more assiduously and more regularly with a view to reducing their risk. The strategy should help us adjust the specific treatment modalities of a patient who has undergone

myocardial revascularization by coronary artery bypass surgery. A venous graft was installed in 60% of our patients. Improved understanding of the physiology of vascular grafts used for myocardial revascularization has allowed us to improve their therapeutic management [19-22]. It is well established that venous grafts degenerate over time (due to accelerated atherosclerosis in the graft) and that this correlates with the recrudescence of patients' symptoms [23]. The degeneration process begins in the operating room and is particularly active in the first year after the procedure [24]. When it comes to slowing such degeneration down, systematic re-evaluation of our patients helped correct prescription errors, notably vis-à-vis statins and angiotensin converting enzyme inhibitors [19, 21, 22, 25]. We therefore hope that this strategy can help protect venous grafts against atherosclerotic damage. Moreover, we observed that about one patient in three was suffering from residual ischemia according to a scintigraphic examination. This ischemia (pointing to incomplete revascularization) itself constitutes a major risk factor. Our protocol allows us to step up anti-ischemic treatment and consider secondary angioplasty. Finally, we observed that atherosclerosis of peripheral vessels and the vessels of the neck was common: sustained cardiovascular risk could lead to deterioration in this respect resulting in secondary complications. We are currently evaluating cardiovascular risk in patients with endarteritis obliterans in the lower limbs for whom it was necessary to conduct coronary artery bypass surgery.

Conclusion

In conclusion, our approach should help optimize patient care with the ultimate aim of arresting the progression of atherosclerotic involvement of the original coronary network as well as preventing graft degeneration, thereby cutting down secondary ischemic manifestations at the cost of a three-day hospital stay. We believe that this cost (compared with outpatient care) should be weighed up against those of all the professional health care providers (doctors, physical, therapists, nurses, dietitians, psychologists, etc.) and tests (ultrasound, scintigraphy, Doppler, etc.) that might otherwise have to be administered to obtain the same reduction in risk level. We are currently in the process of working on how to implement such a strategy at an earlier stage in collaboration with re-education units, especially for patients at the highest risk. Finally, the real benefits of this type of strategy can only be ascertained after a far longer follow-up period.

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